Fig. 1, CRYPTOZOON BOREALE, Dawson.

Ordovician, Lake St. John, P.Q., Canada. *Two of the Branches of a large Compound Mass, Natural size.* Collected by Mr. E. F. Chambers.
(From a Photograph.)

THE

CANADIAN RECORD

OF SCIENCE.

VOL. VII. OCTOBER, 1896. No. 4.

Note on Cryptozoon and other Ancient Fossils.

By Sir William Dawson, F.R.S., F.G.S., &c.

For many years my attention has been directed, in connection with the discussions regarding Eozoon, to the discoveries made from time to time of organic remains older than the Lower Cambrian, and to the study of fossils occurring in the Cambrian, and which might be supposed likely to be survivals from the Pre-cambrian periods. It is now well known that in the Lower Cambrian seas there already existed representatives of all the classes of Marine Invertebrates, and these represented probably by several hundreds of species of many genera, since the published lists of American forms alone contain more than 160 species.[1] In the beds immediately below the Cambrian, however, though several forms of life have been recognised by Billings, Matthew, Walcott and others, they are comparatively rare in numbers and sparsely distributed through great thicknesses of unproductive beds; and this in connection with the frequently disturbed and altered condition of the beds themselves, renders any attempt to

1 Walcott: Memoir on Fauna of Lower Cambrian, 1890. Publications of U.S. Geological Survey.

collect Pre-cambrian fossils tedious and difficult, as well as often unremunerative.

In the present paper I propose to notice some Pre-cambrian—or possibly Pre-cambrian—fossils, as much with the object of directing the attention of younger geologists to the collection of organic remains in these rocks as for any other purpose, since our knowledge of the Pre-cambrian fauna is yet in its infancy, and may be regarded rather as something to be hoped for in the future than as a present possession.

I am disposed to follow Matthew in placing as Pre-cambrian, though still Palæozoic, the beds in Southern New Brunswick designated by him as Etcheminian, and holding a few fossils of Palæozoic types, and to correlate with these the Signal Hill Series of Newfoundland and the Kewenian or Kewenawan of Lake Superior.[1] Below these, so far as yet known, we have only the Huronian, probably divisible into an upper and lower member, the Grenvillian or Upper Laurentian—the two constituting the Eozoic group,—and the Lower Laurentian, Ottawa gneiss or Archæan proper.

I. Cryptozoon.

In 1882 Prof. James Hall described certain remarkable stromatoporoid forms found by him in a limestone of the Calciferous formation at Greenfield, Saratoga County, New York, and which he named *Cryptozoon proliferum*.[2] The specimens occurred abundantly on the surface of the bed, and were of rounded form and closely grouped together, as if by a process of lateral gemmation. Each individual is described as consisting of "a number of irregular concentric laminæ of greater or less density and of very irregular thickness. The substance between the

1 Matthew, Trans. Acad. Science, N.Y., March, 1896; Trans. Royal Soc. of Canada, 1889, etc. See also "Canadian Record of Science," 1896.

2 Thirty-sixth Regents' Report on New York State Cabinet.

concentric lines, in well-preserved specimens, is traversed by numerous minute irregular canals, which branch and anastomose without regularity. The central portions of the masses are usually filled with crystalline, granular and oolitic material, and many specimens show the intrusion of these extraneous and inorganic substances between the concentric laminæ."

In general form the masses are hemispherical or broadly turbinate, and the layers are concave upward as if they had grown from a central point or circle and expanded very rapidly in ascending, the general result resembling a series of bowls one within another. The larger masses are from one to two feet in diameter.

Thin slices, from specimens kindly presented to the Peter Redpath Museum by Prof. Hall, show that the primary laminæ are thin and apparently carbonaceous, as if originally of a corneous or membranous character, and they are usually finely crumpled as if by lateral pressure,[1] while they can occasionally be seen to divide into two laminæ with intervening coarsely cellular structure. The thick intermediate layers which separate these primary laminæ are composed of grains of calcareous, dolomitic and silicious matter, in some specimens with much fine carbonaceous material. This last, under a high power in thin slices, is seen to present the appearance of a fine network or stroma in which the inorganic particles are entangled. The canals traversing these intermediate layers appear to be mere perforations without distinct walls, and are filled with transparent calcareous matter, which renders them, under a proper light, sufficiently distinct from the grey granular intermediate matter which they traverse. So far as observed, the canals are confined to the intermediate layers, and do not seem to penetrate the primary laminæ, though these sometimes present a reticulated appearance

[1] This may, however, represent an originally corrugated structure of the laminæ.

and seem to have occasional spaces in them which may have been communicating pores or orifices.[1]

In 1885 Prof. N. H. Winchell recognised a similar structure in stromatoporoid forms found in a limestone underlying the St. Peter sandstone, and therefore of Upper Cambrian age. These are noticed in his 14th Annual Report under the name *Cryptozoon Minnesotense*, and are stated to differ from Hall's specimens in their habit of growth, the laminæ being convex or conical upward. The structure also is somewhat different, the lamination being much finer.

In 1889 the Minnesota specimens were again noticed by Mr. L. W. Chaney, more especially with reference to the great size attained by some of them, though there seemed to be doubt as to whether the very large specimens may not have been enlarged by aggregation of concretionary matter. In this paper also, the discovery of Cryptozoon in the calciferous of the Champlain Valley, by Prof. H. M. Seely, is mentioned.

About this time I had obtained from the Calciferous of Lachute, P.Q., a large stromatoporoid mass, and in examining it microscopically found that, though less perfectly preserved than Hall's specimens, it might be referred with probability to the same genus. The laminæ are more waved, and often connected with each other, and the canals less curved and more frequently expanding into irregular cavities. I cannot positively affirm that this is a distinct species, but may provisionally name it *C. Lachutense.*

In 1890, the Cryptozoa of the calciferous of the Champlain Valley are referred to by Messrs. Brainard and Seely, and one species is named *C. Steeli*, in honour of Dr. Steel, who first observed them in 1825.[2] This species is stated

1 Thin horizontal sections of the laminæ in the best specimens indeed appear as if constituting a reticulated mat, more dense than that seen in the intermediate layers.

2 Bulletin Geol. Socy. of America, Vol. I, p. 502.

in the same paper to appear in the calciferous of Philipsburgh on the Canadian frontier. Prof. Seely informs me in a private letter that he has since recognized in the Champlain Valley what appear to be two additional species of Cryptozoon.

Cryptozoon Boreale, Dawson (Fig. 1).—A quite distinct and very interesting species was obtained in 1888 by Mr. E. F. Chambers, of Montreal, at Lake St. John, P.Q., associated with fossils of Trenton age. It consists of a mass of cylindrical or turbinate branches, proceeding from a centre and also budding laterally from each other. Each branch shows a series of laminæ concave upward. The spaces between the thin laminæ are filled with a very fine granular material, in which are canals, less frequent straighter and more nearly parallel to the laminæ than in the typical species. This species is remarkable for the slender and coral-like shape of its branches, for its resemblance in general form to the disputed specimens resembling Eozoon from the Hastings (probably Huronian) of Tudor, Ontario, and on account of its being the latest known occurrence of Cryptozoon. It was very shortly described and commented on in the "Canadian Record of Science" for 1889.

Cryptozoon Occidentale, S.N.—So far our specimens of Cryptozoon have been Upper Cambrian or Ordovician, but Dr. C. D. Walcott, in his memoir on the Fauna of the Lower Cambrian, mentions at p. 550 that in the Grand Cañon section in Arizona, there are unconformably underlying the Lower Cambrian "12,000 feet of unaltered sandstone, shale and limestone," which may be regarded as Pre-cambrian, and probably in whole or in part representing the Kewenian of Lake Superior and the Etcheminian of Southern New Brunswick. In these beds, 3,500 feet below the summit of the section, he found "a small Patelloid or Discinoid shell," a fragment probably of a Trilobite, and a small Hyolithes, in a bed of bituminous limestone.

"In layers of limestone still lower in the section an obscure *Stromatoporoid form* occurs in abundance, along with fragments of a Trilobite and a Salterella." Small specimens of these stromatoporoid forms were kindly supplied to me by Dr. Walcott, and on being sliced, though most of them were imperfectly preserved, one of them exhibited the concentric laminæ of Cryptozoon, and the intermediate layers composed of microscopic grains which were ascertained by Dr. Adams to be partly siliceous and partly calcareous (Dolomite and calcite). Instead of the irregular curving canals of the typical Cryptozoon, where best preserved they show ragged cells, giving off on all sides numerous small tortuous and branching canals (Fig. 3), but this structure I regard as possibly corresponding to that of Cryptozoon, and I would therefore venture to name the species *C. Occidentale*, in hope of the discovery of better specimens.

II. Archæozoon.

Still older specimens referable to the same general type have been found by Dr. G. F. Matthew in the Upper Laurentian (Grenville Series) of Southern New Brunswick. Dr. Matthew having kindly presented a large slab of these fossils to the Peter Redpath Museum, I have been enabled to study them both macroscopically and microscopically. As described by Matthew, with reference to their mode of occurrence *in situ*, they consist of cylindrical or polygonal columns apparently multiplying by budding, and composed of laminæ and intermediate layers which are convex upwards and are in places separated by spaces occupied with calcite.[1] The laminæ have the same aspect with those of Cryptozoon; but the intervening thick granular layers, which have a very uniform appearance,

[1] In the slab presented to the Peter Redpath Museum the individual masses are apparently not *in situ*, but more or less broken and piled up together; some of them are six inches in diameter. The laminæ of white calcite in several of the specimens I regard as inorganic and filling lacunæ or cavities.

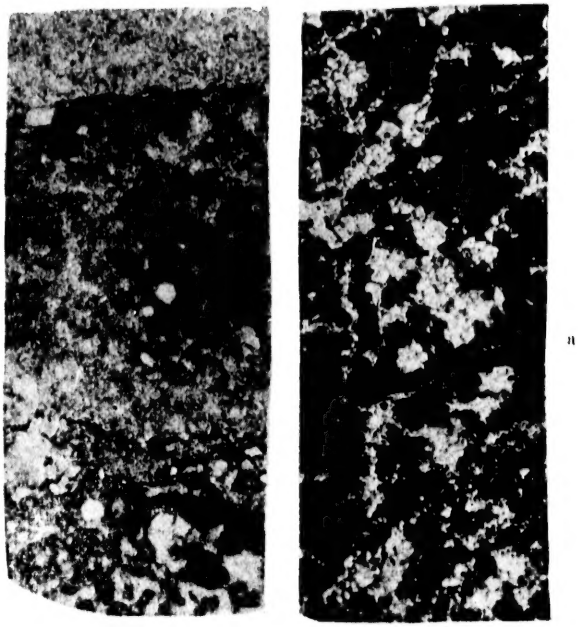

FIG. 2. FIG. 3.

FIG. 2.—Section of part of Cryptozoon proliferum, Hall, x 48, showing two of the primary laminæ at (a, a), and portions of three of the canaliferous layers.

FIG. 3.—Section of part of C. Occidentale, S.N., x 48, showing one of the primary laminæ at (a), and portions of two of the cellular and canaliferous layers.

(From micro-photographs by Prof. Penhallow.)

exhibit canals only in places. Elsewhere they may have perhaps been destroyed by decay and pressure. Matthew regards these forms as fossils; and if so, they are undoubtedly allied to Cryptozoon, if not properly belonging to the genus. They are in any case the oldest known forms referable to this type. In other beds of the same age fragments of Eozoon showing the canal systems have been found, and also needles supposed to be spicules of sponges, and carbonaceous films and fibres which may be of vegetable origin.

III. General Remarks on Cryptozoon and Archæozoon.

If we endeavour in imagination to restore these curious organisms, the task is a very difficult one. They no doubt grew on the sea bottom, and must have had great powers of assimilation and increase in bulk. Still, it must be borne in mind that they were largely made up of inorganic particles collected from the mud and fine sand in process of deposition. The amount of actual organic matter in the hard parts even of large specimens is not very great, and the soft living material, if they were animal, must have been confined to the canals and to the exterior surfaces.

As the only marine animals known to accumulate foreign matter in this manner are the Protozoa of the Rhizopod type, one naturally turns to them for analogies, and perhaps species of the genus Loftusia most nearly resemble them in general arrangement. But this type is, I believe, not known lower than the Lower Carboniferous; *L. Columbiana*, A. M. Dawson, found with the genus Fusulina in rocks of that age in British Columbia, being the oldest known species.[1] I am not aware that any of the Stromatoporæ, properly so called, as nearly resemble Cryptozoon, unless my genus Megastroma from the Carboniferous of Nova Scotia is referable to that group.

[1] Journal London Geol. Survey, Vol. 35, p. 69, et seqr.

This curious fossil was described with some other Carboniferous forms in the Report of the Peter Redpath Museum for 1883, and as that publication is not very generally accessible, the description may be repeated here:—

Megastroma laminosum, Dawson.

"Broadly expanded layers about one millimetre in thickness, and two millimetres or more apart. Each layer consists of a double membrane, beset with numerous spicules pointing inwards and looking like two brushes facing each other. The membranes are penetrated by openings or oscula, and appear to be porous or reticulate in their substance and to have cellular thickenings in places, giving them a netted appearance. The layers sometimes though rarely unite, and are not always continuous when seen in section; this appearance being perhaps produced by large openings or spaces. In each layer the ends of the opposing spicules are sometimes in contact, sometimes separated by a space, empty or filled with calcite. The intervals between the layers are occupied by organic limestone, consisting of small shells and fragments of shells and corals. As many as twelve or thirteen layers are sometimes superimposed, and their horizontal extent seems to amount to a foot or more. The layers have a deep brown colour, while the enclosing limestone is of a light gray tint.

"This remarkable body was found in the fossiliferous limestone of Brookfield, in patches parallel with the stratification, and at first sight resembled a coarse *Stromatopora*. When sliced and examined under the microscope, it presents the appearance above described. The membranes referred to, from their deep brown color, would seem to have been of a horny or chitinous character. They are sometimes bent and folded, as if by pressure, and appear to have been of a flexible and tough consistency.

The spicules connected with them, if organic, would seem to have been set in the membrane, and to have been corneous rather than silicious. I have, however, no absolute certainty that these apparent spicules may not be rather the effect of prismatic crystals of calcareous spar penetrating a soft animal matter and impressing on it their own forms. If the spicules are really organic, the structure must be of the nature of a sponge. If otherwise, it must have consisted of double membranous layers enclosing between them a softer organic matter, and sufficiently firm to retain their form till filled in with calcareous fragments. Unless the structure was of vegetable origin, which I do not think likely, it was probably a Protozoan of some kind. In either case it is different from any fossil hitherto found in the Lower Carboniferous limestones of Nova Scotia." It is introduced here merely as a possible successor of Cryptozoon.

I think we are justified in holding that the fossils of the type of Cryptozoon constitute a type differing from that of the ordinary stromatoporæ, and probably inferior to them in organization. At one time I supposed that the Ordovician forms contained in the genus Stromatacerium of Hall might be a connecting link, and in some respects of general arrangement they certainly conform to Cryptozoon: but in so far as I have been able to examine them microscopically, their affinities seem to be with the typical Stromatoporæ. Still, there remains even in my own collection a large amount of material referred to Stromatocerium which has not not yet been sliced and examined.

Of modern forms, that which seems to approach nearest to Cryptozoon is the remarkable organism dredged by Alexander Agassiz in the Pacific,[1] and which has been described by Goës as an arenaceous foraminifer, under the

[1] Lat. 107° N. Long. 8° 4' W., 1,740 fathoms.- "Albatross" Expedition.

name *Neusina Agassizi*.[1] It is of considerable size, the largest specimens measuring 190 mm. in breadth, but is very thin, being only 2 mm. in thickness. The general form is fan-like or reniform, with concentric lines or bands, from the edges of which loose tubes or hollow bundles of fibres project into the water. These bands are described as "chambers," which are, however, crossed by innumerable thick partitions dividing them into chamberlets, and these partitions are composed of a fine corneous stroma or network, in which and on the surface are contained the arenaceous grains that give consistency to the whole. It is evident that such a structure, if fossilized, would resemble a flattened Cryptozoon in form, appearance and structure, except in having rounded chamberlets instead of short tortuous canals, a difference not of essential importance. Goës mentions as probably an allied form *Julianella fœtida*, Schlumberger, from shallow water (five metres) on the West Coast of Africa. It wants the filamentous stroma and has the chamberlets larger and more regular and the lateral tubes more numerous. If these forms are rightly included in Foraminifera, they would strengthen the same reference for Cryptozoon and Archæozoon. In any case they indicate the persistence up to the modern time of organisms apparently of the same general structure.

IV. Girvanella, Nicholson (*Streptochetus*, Seely).

These peculiar fossils were first detected by Nicholson and Etheridge in the Silurian of Girvan in Scotland,[2] and were illustrated by Mr. Wethered, of Cheltenham, at the meeting of the British Association in Liverpool last autumn.[3] A similar form discovered in the Chazy of Vermont by Prof. Seely, of Middlebury College, was

[1] Bul. Mus. Comp. Zoology, Vol. XXIII., No. 5, 1892.

[2] Nicholson and Lydeker, Palæontology, 1889, first described in Memoir on Girvan, 1878.

[3] New Cotteswald Naturalists' Club, Vol. XII, Pt. 1, 1895–6.

described by him as a sponge, under the name *Streptochetus ocellatus*,[1] and appears to be generically the same with Nicholson's species, though belonging to an older formation. These bodies occur in small rounded or elliptical masses, presenting a concentric structure resembling that of Cryptozoon on a small scale. Under the microscope, in specimens kindly communicated to me by Prof. Seely and Mr. Wethered, the layers are seen to be made up of minute tubes twisted together in a most complicated manner. The tubes are cylindrical, smooth, and apparently calcareous, and they do not occupy the whole space, but leave irregular unoccupied cavities. The tubes make up the layers and there do not seem to be any distinct separating laminæ between the layers, or any included earthy matter. In these respects they differ structurally from Cryptozoon, and are certainly at least generically distinct, though having some resemblance in general manner of growth.

Girvanella gives us little assistance in determining the affinities of Cyptozoon, and its own relationships have been very variously interpreted. It has been referred to Hydroids, Protozoa and even to Algæ. Prof. Penhallow, however, who has examined my specimens, does not seem inclined to refer it to the latter, though it has certain resemblances to some of the Siphoneæ. Perhaps the most probable conjecture as to its affinities is that advanced by Nicholson,[2] who compares it with the recent tubulous Foraminifora of the genera Syringammina and Hyperammina of Brady, whose tests present masses of tortuous and in some forms branching tubes, sometimes in concentric layers.

I have recently been able to extend the range of this curious organism downward, by the discovery in a boulder in a conglomerate at Little Metis of numerous examples

[1] American Journal of Science, 1885.

[2] Nicholson and Lydeker, Manual of Palæontology, 1889, p. 127.

of a species which is probably of Lower Cambrian age. It occurs in a laminated imperfectly oolitic limestone, in oval, somewhat flattened masses, the largest of which is 18 mm. in its longest diameter. They show an obscure concentric structure, and are mostly in the state of granular calcite, but in places have the characteristic tubes of Girvanella, though less curved and twisted than those of the Chazy and Silurian specimens, and also of smaller diameter.

The formation holding the conglomerate is the Sillery (Upper Cambrian), but the fossiliferous limestone boulders which it contains are, so far as known, of Lower Cambrian age, to which therefore the specimens in question may with probability be referred. The difference in structure as well as in age entitles this form to a specific name. It may be named *Girvanella antiqua*, and may be defined as similar in size and general structure to *G. ocellata* of the Chazy, but with less convoluted and narrower tubes.

V. Receptaculites, Archæocyathus, &c.

In "The Dawn of Life" (1875), reference was made to the singular and complicated organism known as *Receptaculites*, which at that time was generally regarded as Foraminiferal, and is still placed by Zittel, in his great work on Palæontology, among forms doubtfully referable to that group. It has also been referred to sponges, though on very uncertain grounds. It has not, however, been traced, so far as I know, any farther back than the Upper Cambrian, and no structural links are known to connect it with Cryptozoon or with Archæozoon. It may, however, be regarded as a possible survivor of an ancient type, probably a protozoan, forming an unusually large and complicated skeleton, sometimes a foot in diameter, and which may not improbably have existed much earlier than the time of the

formations in which it has hitherto been found. In any case it should be looked for in the Pre-cambrian beds.

The latest attempt known to me to unravel the relations of Receptaculites is that of Dr. Rauff in the Transactions of the German Geological Society. He repeats and confirms the observations of Billings as to its structure, differing only in rejecting the pores of the internal wall. He also rightly concludes that it must have been a calcareous organism, and consequently cannot be referred to any of the groups of silicious sponges; but seems to regard its systematic position as still quite uncertain. It may possibly remain so, till either modern analogues, or more ancient and simpler forms, shall be discovered. Receptaculites and its allies are at present known as low as the Lower Ordovician on the one hand, as high as the Carboniferous on the other.

Another primitive and apparently very generalised type is the genus *Archæocyathus* of Billings, one of the oldest and most curious Cambrian fossils. It deserves an additional notice here, in connection with facts and publications of recent dates.

As early as 1865 my attention was attracted to these forms by specimens presented to me by Mr. Carpenter, a missionary to Labrador, and about the same time Mr. Billings was kind enough to shew me specimens which had been obtained by Mr. Richardson of the Geological Survey, in what was then known as the "Lower Potsdam" of L'Anse à Loup in that region, and which he had described in 1861 and 1864, stating that he was in doubt whether they should be referred to corals or sponges. Slices of the specimens were made for the microscope, when it appeared that, though they had the general aspect of turbinate corals, like Petraia, etc., they were quite dissimilar in structure, more especially in their porous inner and outer walls and septa, yet they did not closely resemble the porous corals, which besides were regarded as

of much more recent date. Nor could they with probability be referred to sponges, as they were composed of solid calcareous plates which, as was evident from their texture, could not have been spicular, and which, it appeared, must have been composed of ordinary calcite and not of aragonite. One seemed thus shut up to the idea of their being foraminiferal, and if so very large and complex forms of that group, consisting of perforated chambers arranged around a central funnel and occasionally subdivided by thinner curved lanellae. I mentioned them in this connection in the "Dawn of Life" in 1875, not as closely related to Eozoon, but as apparently showing the existence of very large foraminifera in the Lowest Cambrian.

The specimens thus noticed were those named *A. profundus* by Billings, and were from the Lower Cambrian. He had, however, referred to the same genus silicified specimens from the Calciferous or Upper Cambrian, which were subsequently found to be associated with spicules like those of lithistid sponges, and which may have been very different from the species of the Lower Cambrian, and are now indeed placed in a different genus. The subject became in this way involved in some confusion, and the genus of Billings was supposed by some to be referable to corals and by others to sponges. I, therefore, asked my friend Dr. Hinde to re-examine my specimens, and at the same time Mr. Billings placed in his hands examples of the later form, and he also obtained specimens from European localities which agreed substantially with the older of the Labrador specimens, and were from the same ancient horizon. Hinde retains the original and older type from Labrador in Archæocyathus,[1] and places the later form, *A. minganensis* of Billings, in a new genus Archæoscyphia. In this Walcott, in his memoir on the Lower Cambrian fauna, substantially agrees with Hinde. Hinde, however, rejects my foraminiferal suggestion, and

[1] Journal Geol. Society of London, Vol. 45, 1889, pp. 125, *et sequ.*

prefers to regard Archæocyathus as a coral, though he admits that it is of a very peculiar and generalized type, unknown except in the lowest Cambrian; but there very widely diffused, since it occurs in different parts of North America, in Spain and in Sardinia. I think, however, we may still be allowed to entertain some doubt as to its reference to corals, more especially as its skeleton does not seem to have been composed of aragonite. I still continue to hope that, whether Protozoon or coral, it may be traced below the Lower Cambrian, and may form a link connecting the fauna of that age with that of still older deposits. In my description of it in "The Dawn of of Life," in 1875, I have written of it in the following terms:—"To understand Archæocyathus let us imagine an inverted cone of carbonate of lime, from an inch or two to a foot in length, and with its point buried in the mud at the bottom of the sea, while its open cup extends upward into the clear water. The lower part buried in the bottom is composed of an irregular acervuline network of thick calcareous plates, enclosing chambers communicating with one another. Above this, where the cup expands, its walls are composed of thin outer and inner plates perforated with numerous holes in vertical rows, and connected with each other by vertical partitions, also perforated, establishing free communication between the radiating chambers, into which the thickness of the wall is divided." Such a structure might, no doubt, serve as a skeleton for a peculiar and generalized coral, but it might just as well accommodate a protoplasmic protozoon with chambers for its sarcode and pores for emission of its psendepods both outwardly and by means of the interior cup, which in that case would represent one of the oscula or funnels of Eozoon or of the modern Carpenteria.

VI. Pre-Cambrian in Wales.

In the past summer I was enabled to spend a few days, with the assistance of my friend, Mr. H. Tweeddale Atkin, of Egerton Park, Rock Ferry, in examining the supposed Pre-Cambrian rocks of Holyhead Island and Anglesey. Fossils are very rare in these beds. As Sir A. Geikie has shewn, the quartzite of Holyhead is in some places perforated with cylindrical worm-burrows; and in the micaceous shales there are long, cylindrical cords which may be algae of the genus *Palæochorda*, and also bifurcating fossils resembling *Chondrites*, but I saw no animal fossils. I have so far been able to discover no organic structure in the layers of limestone associated with apparently bedded serpentine in the southern part of Holyhead Island. In central Anglesey there are lenticular beds of limestone and dolomite associated with Pre-Cambrian rocks, which Dr. Calloway regards as probably equivalent to the Pebidian of Hicks. In these there are obscure traces of organic fragments; and in one bed near Bodwrog Church, I found a rounded, laminated body, which may be an imperfectly preserved specimen of Cryptozoon or some allied organism. The specimens collected have not, however, been yet thoroughly examined. These, and other pre-Cambrian deposits in Great Britain, correspond in their testimony with the Eozoic rocks of North America, as to the small number and rarity of fossil remains in the formations below the base of the Palæozoic, and the consequent probability that in these formations we are approaching to the beginning of life on our planet. Mr. Edward Greenly, F.G.S., of Achnasheaw, Bangor, is now engaged in a careful revision of the geological map of Anglesey, and will give special attention to Pre-Cambrian fossils. He has already discovered, in rocks supposed to be of that age, organisms recognized by Dr. Hinde as spicules of sponges.[1]

1 Jonrnal Geological Society, Nov., 1896.

In conclusion, it is interesting to note how many large but obscure and problematical organic remains, all apparently of low types and generalised structures, and therefore difficult to classify, cluster about the base of the Cambrian, and appear to point to a primitive world beyond, of whose other inhabitants we know little else except indications of marine worms, of sponges, of a few Protozoa, and possibly of plants. Like the floating *débris* of the land noted by Columbus on his westward voyage, they raise our hope that we are one day to reach and annex to the empire of geological science a new region in which we may be able to see the beginnings of those great lines of life that have descended through the ages, and are alike mysterious in their origin, their development, the decay and disappearance of some of them, and the addition from time to time of new types to their number.

I may add for the benefit of searchers in this field two practical points: (1) Such organisms as most of those referred to in this paper are not attractive to the ordinary collector; because externally they shew little of their structure, which becomes manifest only after they have been cut and etched with dilute acid or prepared in transparent slices for study under the microscope. There can be little doubt that many of them are overlooked for this reason. (2) In Cambrian and Pre-Cambrian formations fossils are often abundant on certain surfaces or in certain thin layers, while intervening beds of great thickness are barren. Hence the importance when productive beds are found, of working them thoroughly when possible. In this the local collector who can revisit the same spot many times and spend days in working at it, has great advantages. Otherwise such productive spots can be adequately worked only by spending money in securing good collectors and giving them sufficient means for excavation.